

Claims

What is claimed is:

1. A device, comprising:

5 an optical resonator configured to support whispering gallery modes and comprising a plurality of sectors that are optically nonlinear and each exhibit an electro-optical effect, wherein nonlinear coefficients of two adjacent sectors are oppositely poled; and

10 an electrical waveguide located relative to the optical resonator to guide an electrical oscillation signal into the optical resonator to spatially overlap with the whispering gallery modes and to modulate an index of the optical resonator via the electro-optical effect.

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2. The device as in claim 1, wherein the optical resonator is a whole sphere.

20 3. The device as in claim 1, wherein the optical resonator comprises a portion of a whole sphere.

4. The device as in claim 1, wherein the optical resonator has a non-spherical shape.

5. The device as in claim 4, wherein the optical resonator
has a spheriodal shape.

6. The device as in claim 1, wherein the optical resonator
5 has a disk shape.

7. The device as in claim 1, wherein the optical resonator
has a ring shape.

10 8. The device as in claim 1, wherein the sectors are
symmetrically arranged with respect to a center of the optical
resonator.

15 9. The device as in claim 1, wherein the sectors are
parallel stripes across the optical resonator.

10. The device as in claim 9, wherein the parallel stripes
have substantially identical stripe widths.

20 11. The device as in claim 9, wherein the parallel stripes
have stripe widths that change with distances between a center
of the optical resonator and the parallel stripes.

12. The device as in claim 1, wherein the sectors comprise two adjacent oppositely poled sectors along a direction around which the whispering gallery modes circulate.

5 13. The device as in claim 1, wherein the sectors are made of LiNbO₃ or LiTaO₃.

14. The device as in claim 1, wherein the electrical oscillation signal has a frequency that is substantially equal
10 to a free spectral range of the optical resonator.

15. The device as in claim 1, wherein the optical resonator has a geometry to yield nonequidistant modes and wherein the electrical oscillation signal has a frequency that is
15 substantially resonant with two different modes of the optical resonator.

16. The device as in claim 15, wherein the optical resonator has a spheriodal shape.

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17. The device as in claim 1, further comprising an optical coupler located relative to the optical resonator and operable to couple an input signal into one mode of the optical resonator and to couple an output signal in another mode of the optical

resonator, wherein the output signal is modulated at a frequency of the electrical oscillation signal.

18. A method, comprising:

5 using an optical resonator to receive an input optical signal, wherein the optical resonator has a geometry to support whispering gallery modes and comprises a plurality of sectors whose nonlinear coefficients are oppositely poled between two adjacent sectors, wherein the sectors each exhibit an electro-
10 optical effect; and

coupling an electrical oscillation signal into the optical resonator to spatially overlap with the whispering gallery modes and to produce an output optical signal having a modulation at a frequency of the electrical oscillation signal.

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19. The method as in claim 18, wherein the sectors are symmetrically arranged with respect to a center of the optical resonator.

20 20. The method as in claim 18, wherein the sectors are parallel stripes across the optical resonator.

21. The method as in claim 18, wherein the electrical oscillation signal has a frequency that is substantially equal to a free spectral range of the optical resonator.

5 22. The method as in claim 18, wherein the optical resonator has a geometry to yield nonequidistant modes and wherein the electrical oscillation signal has a frequency that is substantially resonant with two different modes of the optical resonator.

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23. The method as in claim 18, further comprising controlling a frequency of the electrical oscillation signal to be substantially equal to a free spectrum of the optical resonator to operate the optical resonator in a running wave 15 electro-optical resonator.

24. The method as in claim 1, wherein the optical resonator has a geometry to yield nonequidistant modes, and the method further comprising:

20 controlling the electrical oscillation signal at a frequency that is substantially resonant with two different modes of the optical resonator to produce a single sideband modulation.

25. A device, comprising:

an optical resonator configured to support whispering gallery modes and comprising a nonlinear optical material exhibiting a second-order nonlinear effect and an electro-optical effect, wherein the nonlinear optical material comprises a plurality of sectors arranged in a quasi phase matching configuration for nonlinear wave mixing of an input optical signal in a first whispering gallery mode, an output optical signal in a second whispering gallery mode, and an electrical oscillation signal spatially overlapping with the whispering gallery modes;

an electrical waveguide located relative to the optical resonator to guide the electrical oscillation signal into the optical resonator to spatially overlap with the whispering gallery modes and to modulate an index of the optical resonator; and

means for coupling the input optical signal into the optical resonator and the output optical signal out of the resonator.

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26. The device as in claim 25, wherein the optical resonator includes at least a portion of a sphere.

27. The device as in claim 25, wherein the optical resonator has a non-spherical shape.

28. The device as in claim 25, wherein the sectors are
5 symmetrically arranged with respect to a center of the optical resonator.

29. The device as in claim 25, wherein the sectors are parallel stripes across the optical resonator.

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30. The device as in claim 25, wherein the coupling means comprises a single optical coupler.

31. The device as in claim 25, wherein the coupling means
15 comprises an input optical coupler and an output optical coupler.